

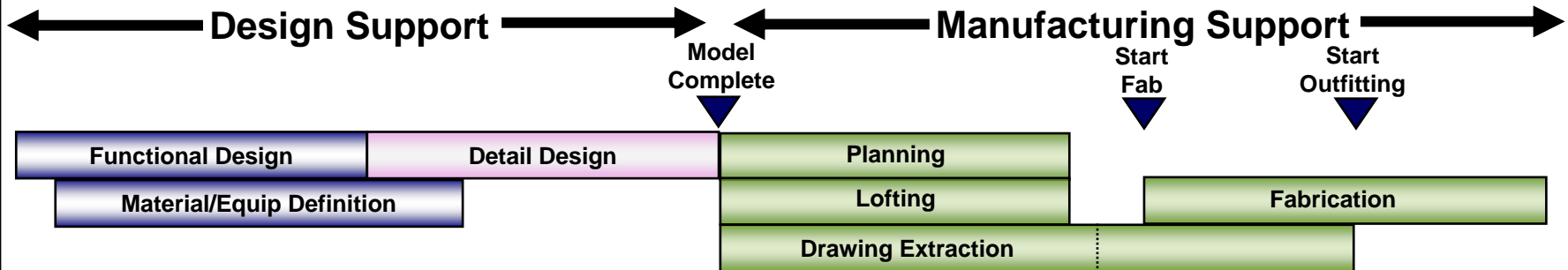
GENERAL DYNAMICS

Bath Iron Works

Detail Design Overview - Ship Design Maturity

Jerry Cashman
BIW Design Manager
31 March 2009

Detail Design Flow – Typical Zone



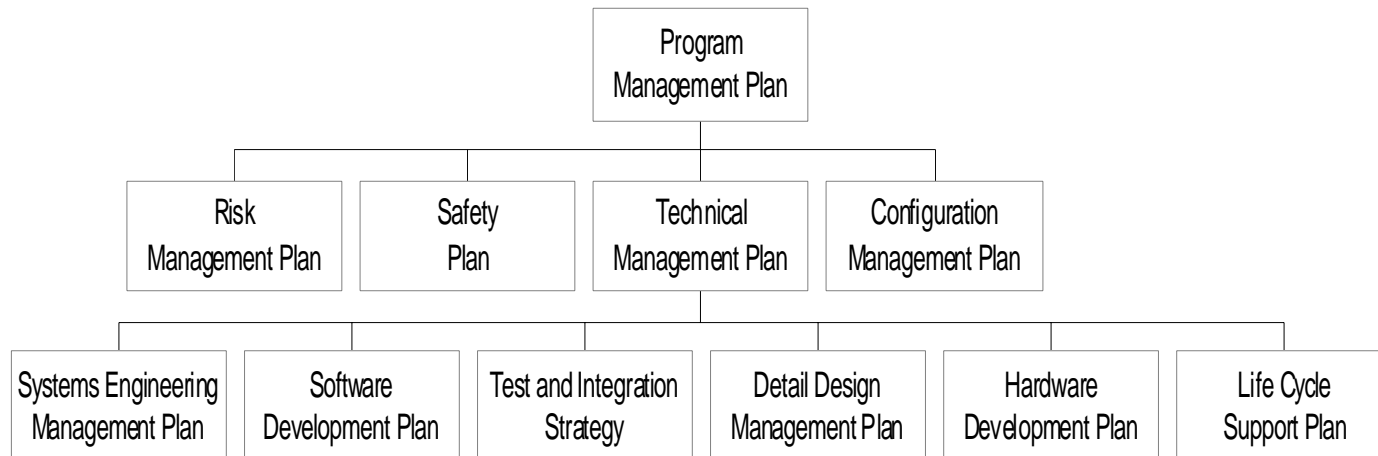
- Input required from the Preliminary / Concept Design phases
- Simple Concept but complex in execution (design spiral)
 - 4 major steps
 - Functional Design
 - Material definition and Major Equipment purchase
 - Detail Design includes Transition Design / Priority Routing
 - Production design
- Supplemented by a robust Design Build approach
- Establishment of Program Execution Plans, CAD architecture and integrated design schedules need to be in place prior to Detail Design start

Design spiral is both planned and unplanned

Program Management Plans

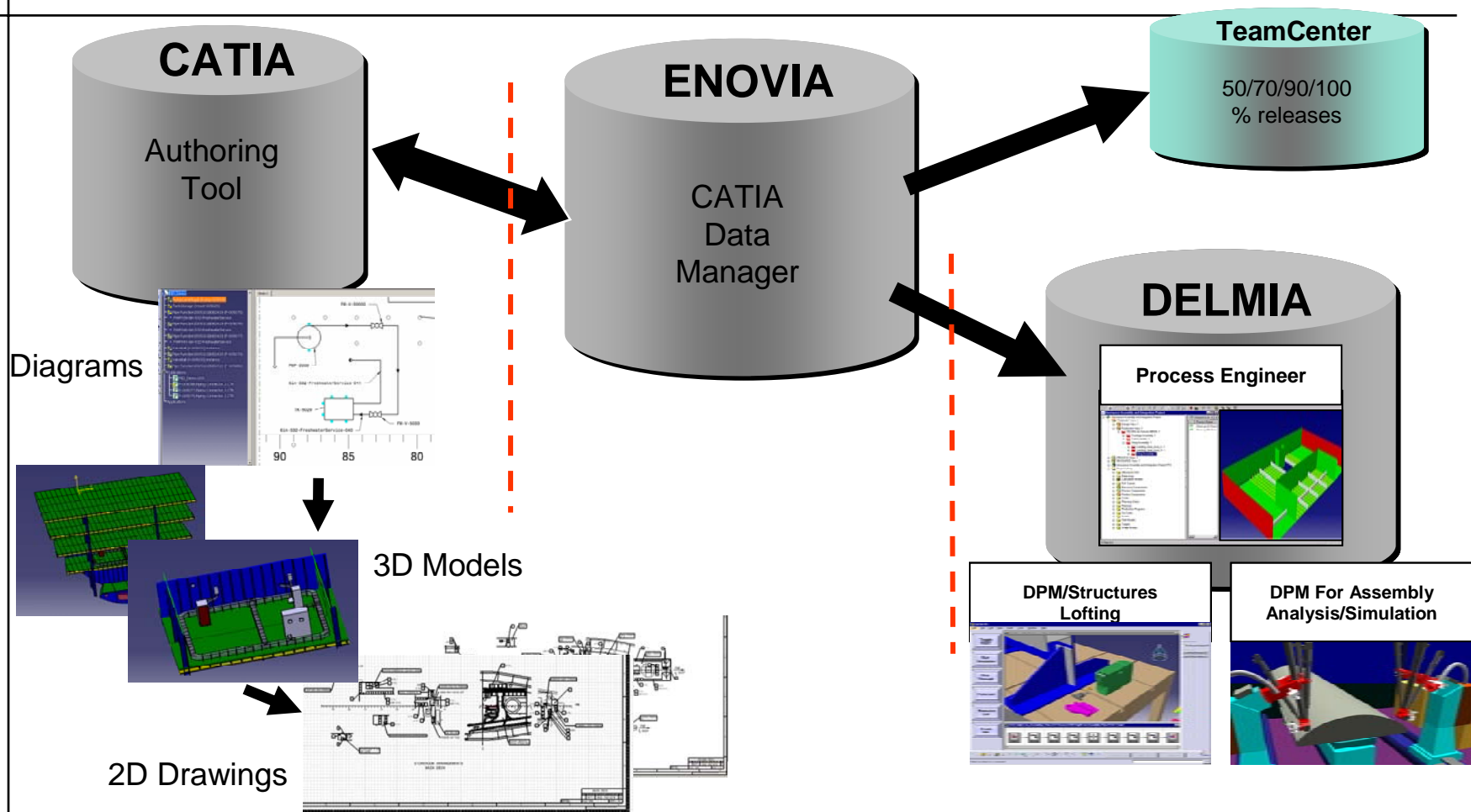
Establishment

- The Detail Design Management Plan (DDMP) defines the overall management structure and organizational relationships as well as the design process to be implemented during detail design phase and construction. This plan was supplemented by design discipline craft Memorandum on Agreements (MOA's). These MOA's defined the agreed to producibility requirements and the minimum design requirements that each shipbuilder would require to efficiently build the ship.
- Relationships to Other Management Plans:



General Hierarchy of Plans

CATIA / ENOVIA V5 Architecture



Design CAD tools are only part of the overarching architecture

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Handle material as required by protective markings on cover.

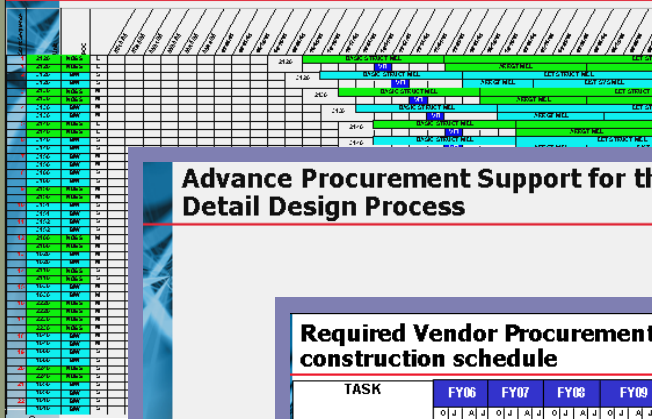
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Detail Design Overview
31 March 2009

Integrated Master Schedule Established

DD(X) Top Level Detail Design Schedule

FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
O J A J	O J A J	O J A J	O J A J	O J A J	O J A J	O J A J	O J A J	O J A J
	System PRR	Start Fabrication	Lay Keel		Launch Electronics Light Off	Delivery	Final Contract Trial Cert	ITC DC

Detail Design Zone Schedule



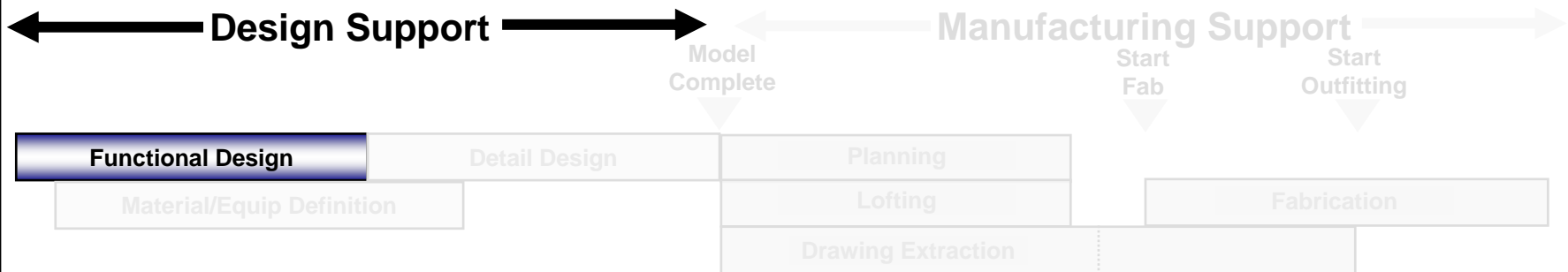
Advance Procurement Support for the Detail Design Process

Required Vendor Procurement to support construction schedule

TASK	FY06	FY07	FY08	FY09	FY10	FY11	FY12
	O J A J	O J A J	O J A J	O J A J	O J A J	O J A J	O J A J
Misc Docs		System PRR	Start Fabrication	Lay Keel	Launch	Electronics Light Off	
Medium Voltage Switch	PO VR 6/28/08			VR 11/27/08	VR 11/27/08		
400V Elec Load Center	PO 6/28/08	VR 11/27/08					
Motor, AUM	PO VR 6/28/08						
Main E. Aux. Gas Turbine	PO 6/28/08	VR 11/27/08					
SWBS #55, IFF Bay Distribution Unit Cabinet	PO 6/28/08	VR 11/27/08					
SWBS #42, KA Ball Transmittal Aperture	PO 6/28/08	VR 11/27/08					
SWBS #47, IFF Transceiver Coupler & Controllers	PO 6/28/08	VR 11/27/08					
SWBS #45, IFF Transceiver Aperture Control Board	PO 6/28/08	VR 11/27/08					
SWBS #56, VSR Off Array	PO 6/28/08	VR 11/27/08					

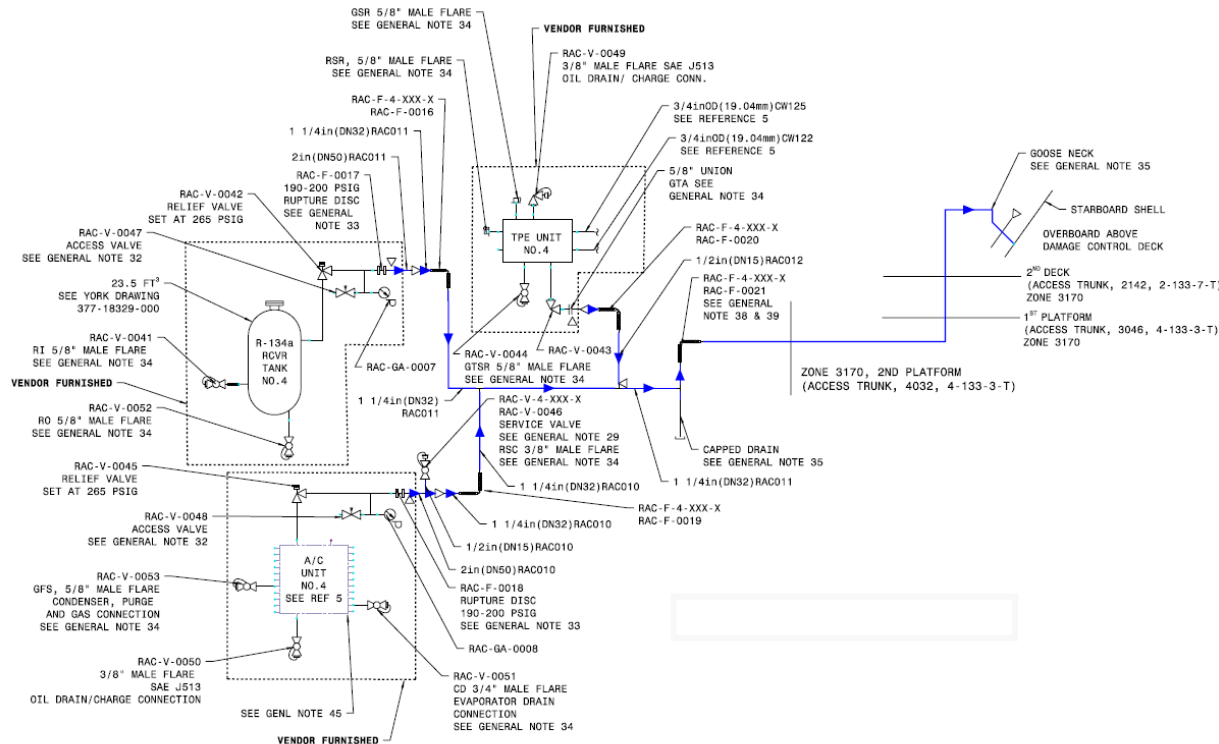
- Top Level Detail Design Schedule Supports Ship & Combat System development
- Collaborative Detail Design Zone Schedule allows concurrent design of all four modules
- Common Procuring approach and schedule set back established
- VFI schedule laid out for key systems

Functional Design



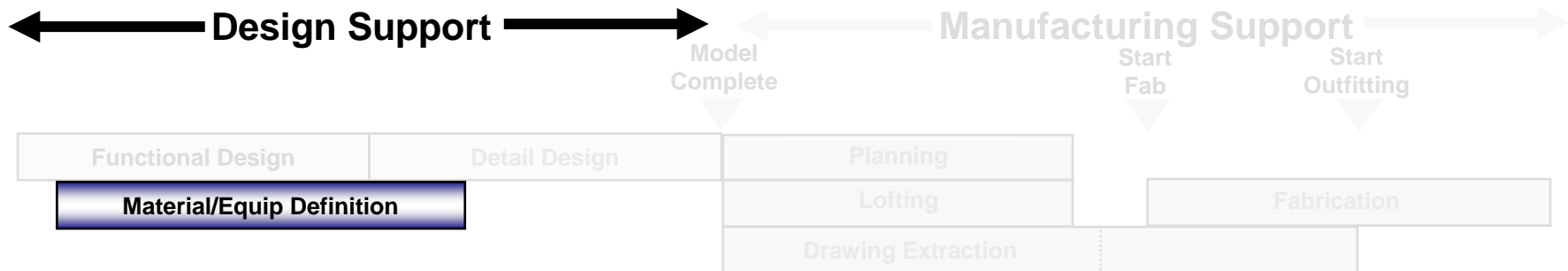
- What Is It?
 - ↗ Translates requirements into functional products
 - Diagrams, scantlings, purchase specs, initial calculations, system descriptions and analyses
 - Final analyses and selected record drawings
- How is it Used?
 - ↗ Generates definition for procurement
 - ↗ Supports Initial arrangements
 - ↗ Defines connectivity between systems and within systems
- How is it measured?
 - ↗ Functional design product completes
 - ↗ ABS submittals
- How is it validated by a third party?
 - ↗ Approval of products by Naval Technical Authority / ABS

Functional Diagrams in CATIA



CATIA Diagrams have the look and feel of traditional functional diagrams, but are data rich and fully integrated into the CATIA detail environment

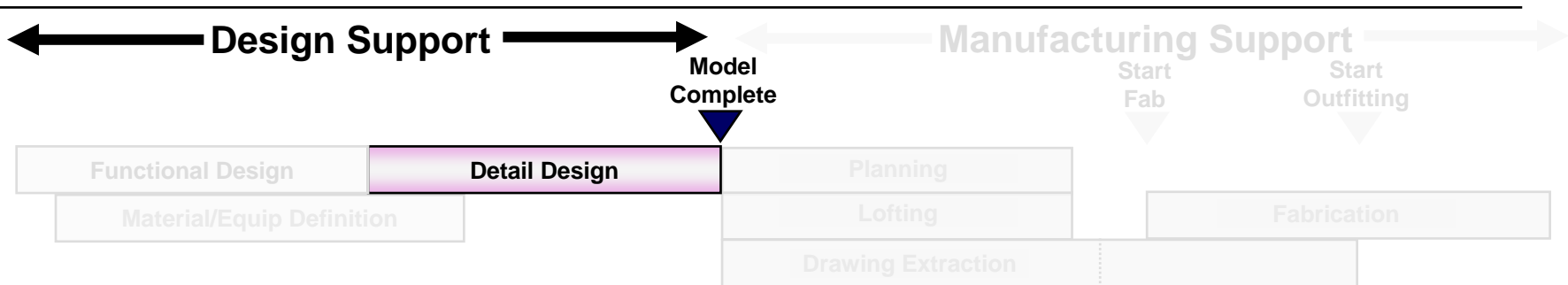
Material Equipment Definition



- What Is It?
 - Takes functional requirements and develops contract documents to procure design vendor furnished information (DVFI) and equipment
- How is it Used?
 - DVFI provides definition of equipment located in model, defines interfaces (size, weight, hookups, heat rejection)
- How is it measured?
 - Specs complete, contracts awarded, DVFI obtained, Delivery order status, CDR/RFM completed
- How is it validated by a third party?
 - ABS approval of selected equipments

Final VFI availability at design start will minimize rework

Detail Design – Transition / Zone



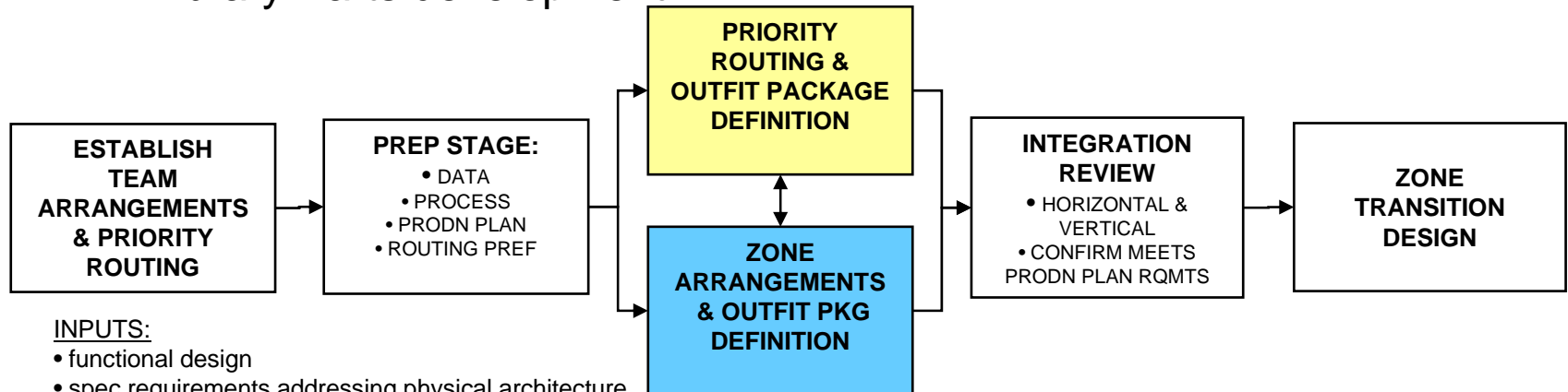
- What Is It?
 - 3D model is a geometric, data rich representation of ship zones in CATIA
 - 3D models evolve:
 - Preliminary Arrangements
 - Distributed systems
 - Final Arrangements
 - Complete Attribute data (DVFI, production data)
- How is it Used?
 - Develops build plan, supports production design (drawing development)
 - Supports detailed production planning/work order development and material ordering
- How is it measured
 - Arrangeability Assessment
 - Arrangement completes
 - Model completes
- How is it validated by a third party?
 - Multiple third party stakeholders (Design Review Report Card)
 - 50%, 70%, 90% Reviews
 - Design For Manufacturing Metrics
 - Design Model Closure Report verified by associate shipbuilder

Design Maturity Processes

- Global Transition Design is where the functional system definition and arrangement design meet for the first time early in the process. Transition Design is accomplished prior to Zone Design to ensure a common design build approach is applied and allows functional engineers to influence the arrangements to ensure the optimal system performance and total ship integration.
- Shipyard design on-site reps were established in DC to ensure issues are properly vetted across Navy and prime technical leads prior to discussion at the SDM / SIT.
- Arrangeability Assessment Process was proactively applied to resolve zone arrangement issues.
- Design Exceptions Process was established to support design progress/maturity.
- RCIA Process supports continuity and momentum of design maturity by providing advanced authorization of design solutions.
- Zone Design Review Stakeholder Team created an effective review process in support of measuring the overall design maturity.
 - Navy, Tech Warrant holders, HSI, Engineering / Design, Safety, Weight Control, Integrators, Shipbuilder Design Build Reps

Transition Design

- Global Transition Design begins the process of transforming the functional definition into physical architecture
 - Ensure that the ship's architecture supports the Production Plan, Test Plan and DFM preferences
 - Structural functional design
 - Outfit arrangements & priority routing
 - Library Parts development



INPUTS:

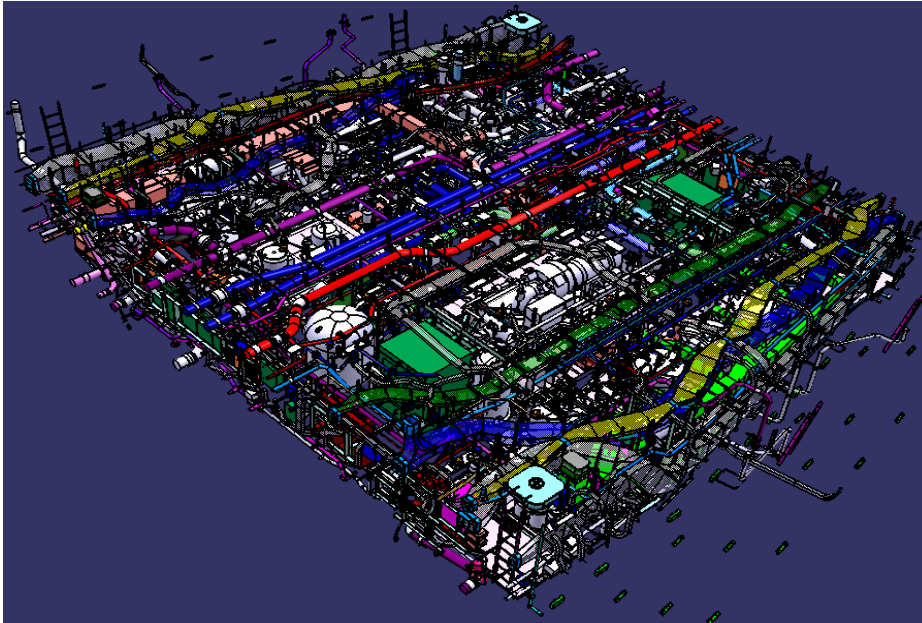
- functional design
- spec requirements addressing physical architecture (arrangements, separation, survivability)
- arrangement & outfit package requirements supporting production plan
- manufacturing preferences for priority routing

Zone Design – Design Reviews

- Arrangements Complete Criteria
 - Arrangements finalized
 - Distributive systems complete
 - Outfitting Complete
 - Stakeholders' comments from prior design reviews incorporated and validated
 - Design/Build and Design for Manufacturing (DFM) input
 - Visual Global Interference Interference Check conducted
 - Design Review Scorecard
- Model Complete Criteria
 - Stakeholder signoffs
 - Attributes complete
 - Piece breaks approved by Design for Manufacturing (DFM)
 - Data integrity scripts run and issues resolved
 - Design validation complete
 - Model reservations added for items that may change (to show risk to production planning)
 - Design Model Closure Report

Well defined criteria assures high quality to production trades

AMR #1 Model at 90% Completion

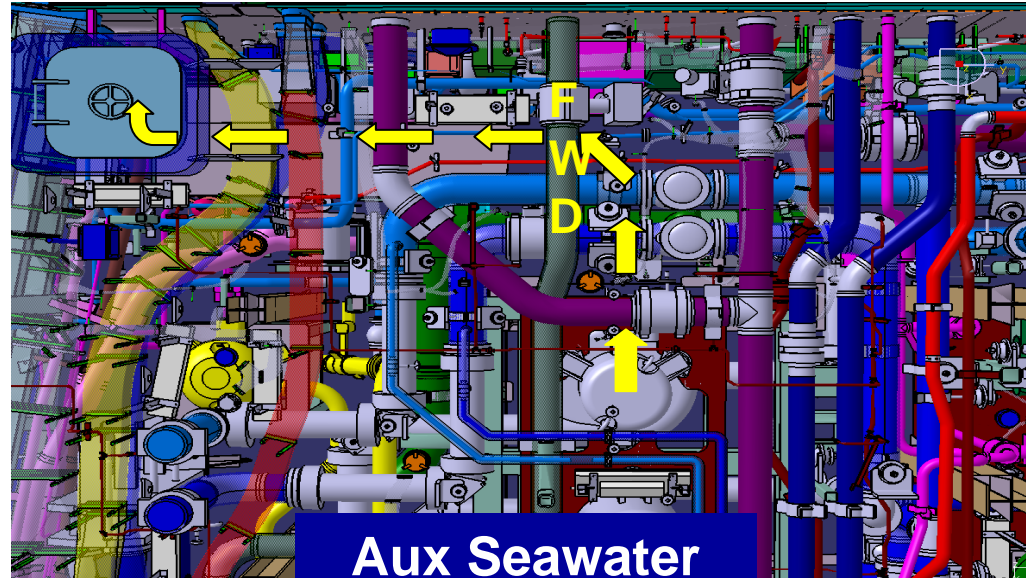


- DDG 1000 Design contains an unprecedented level of detail compared to other programs
- Library Part definition - multiple envelopes are applied to each library part (maintenance, operational, service, shock, insulation)
 - DDG 51 had 1 envelope
- Ergo Man utilization
- Removal route demonstrations
- Modeling definition - instrumentation piping, pipe hangers, backup structure, insulation, local wireways, loose parts associated to its component, fabrication level of detail

Design maturity prior to drawing extraction start

Removal Route Demonstrations

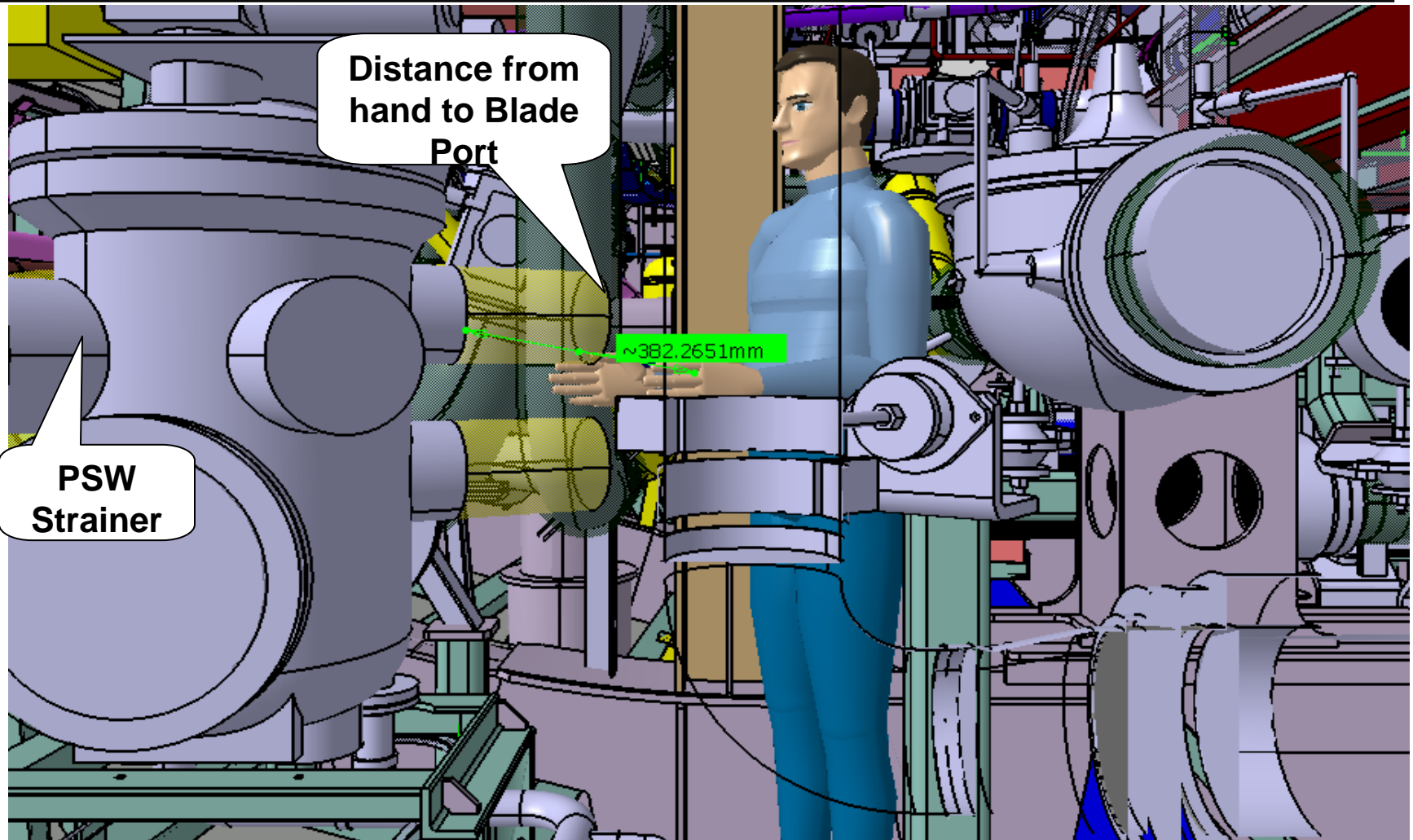
- Removal of Auxiliary Seawater Cooling Pump
- Pump is removed down through the raft into a horizontal position
- Pump is then moved with 3 ton chain falls to overhead WERP
- Pump is rotated into a vertical position and lifted to the overhead zone



**Aux Seawater
Cooling Pump
Removal**

Removal Routes were successfully conducted on each major piece of equipment for every zone

Model Reviews – Robust Design Tools



CATIA V5 - [ENOVIA5\DDX.CATProduct]

Start File Edit View Insert Tools Window Analyze Help

DDX

BD162501MCXXXAM00000 (BD162501MCXXXAM00000.1)

PLANT_AC_500_TON (BM-ACP-B000027)

Attributes for AC Plant

Properties

Current selection: BM-ACP-B000027/BD162501MCXXXAM00000.1/DDX

Graphic Product Piping Equipment HVAC Object

Filter...

Attributes

ARFC:	RFS-BW-000754
Associated Loose Parts:	No value available
BIW/CatalogNumber:	98953086
Cable Cut In Length:	63in
Class:	<Unset>
CompartmentFunctionNumber:	5016
CompartmentName:	AMR NO. 1
CompartmentNumber:	S-62-0-E
CompartmentType:	AUXILLARY MACHINERY SPACE
DamageControlClassification:	
DiagramNumber:	B9532001
Document CageCode:	<Unset>
DocumentIDSpecification:	<Unset>
DrawingNumber:	B0501001
Driver:	<Unset>
EConnectIn:	115 VAC SINGLE PHASE 60 HERTZ
Equipment Name:	PLANT_AC_500_TON
FindNumber:	AC PLANT NO. 4
Grade:	<Unset>
MakeOrBuy:	B
Material:	N/A
MeID:	BM-MEF-B000189
NavyComponentNumber:	<Unset>
NCN:	4120-DA0-760895
NounName:	PLANT/AIR CONDITN
PartDescription:	PLANT/AIR CONDITN/N/A/N/A/P/S ITEM # 001, 500 TON AIR CO
PartSpecification:	<Unset>
PartStatus:	<Unset>
PartVFIStatus:	Final (EBW)
PieceNumber:	C0002
Placed Part:	YES
ProcurementSpecification:	Q2-02002-01;001
Remarks:	<Unset>
Revision:	<Unset>
ShockGrade:	<Unset>
SizeRating:	500 TON
System:	
Total Insulation Thickness:	0in
Type:	<Unset>
UnitOfMeasure:	EA
VConnectIn:	<Unset>
Weight:	0kg
Weight Dry:	13607.769kg
Weight Wet:	0kg

More...

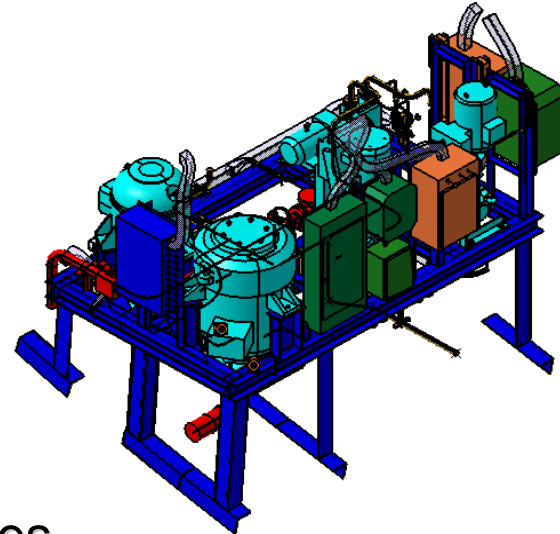
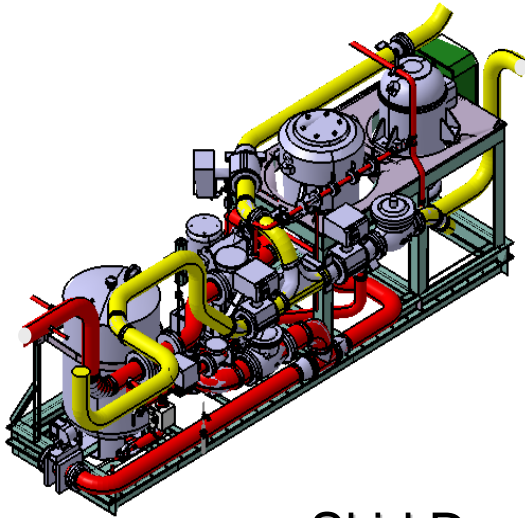
OK Apply Close

Select an object or a command

Start Mike G... 8 Int... 2 Mic... 5 Wi... C:\WI... ENOVIA... 5 Mic... 07719 ... CATIA... 4:06 PM

**A common set of attributes supporting both Shipbuilders
were included in model before model release**

Ship Producibility Arrangement Requirements



Skid Design Examples

- Producibility Arrangement Requirements Identified Skid design requirements
- Shipbuilder Design and Design Build groups worked together to ensure Skid design meet design and producibility requirements for both shipbuilders
- Shipbuilder Producibility groups are grading/signing off on skid designs as part of the review process

Consistent producible design for manufacturing

Design for Manufacturing Metrics

- Summary metric data represents status at latest milestone
 - Completed design reviews

	PIPE LENGTH & DIRECTION CHANGES-RD1			PIPE BENDS - RD9					VENT LENGTH & DIRECTION CHANGES - RD2		
SHIP	TOTAL LENGTH (meters)	TOTAL DIRECTION CHANGES	TOTAL DIRECTION CHANGES PER METER	TOTAL DIRECTION CHANGES	STANDARD BENDS	NON-STANDARD BENDS	ELBOWS	PERCENT OF STANDARD BENDS	TOTAL LENGTH (meters)	TOTAL DIRECTION CHANGES	TOTAL DIRECTION CHANGES PER METER
TOTAL	75,204.8	61,355	0.82	61,355	37,332	15,164	8,859	61%	9,462.1	7,476	0.79

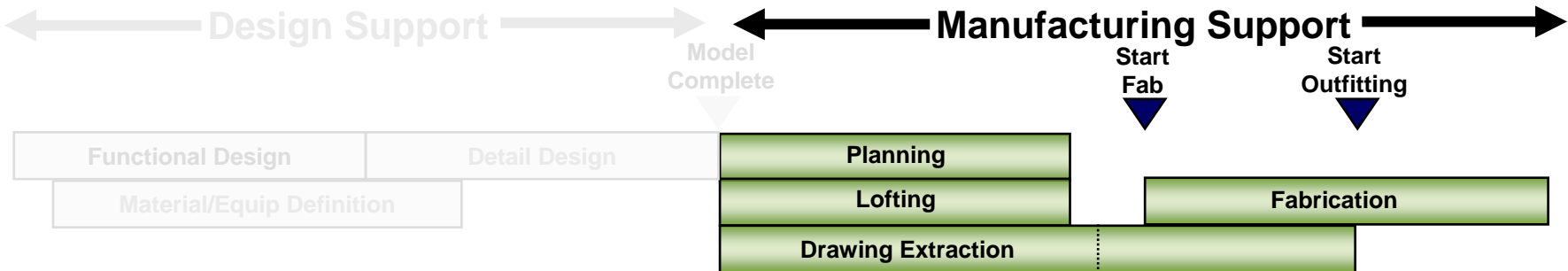
Better than planned of 1.5

Better than planned of 40%

Better than planned of 0.9

Design For Manufacturing results in simpler design

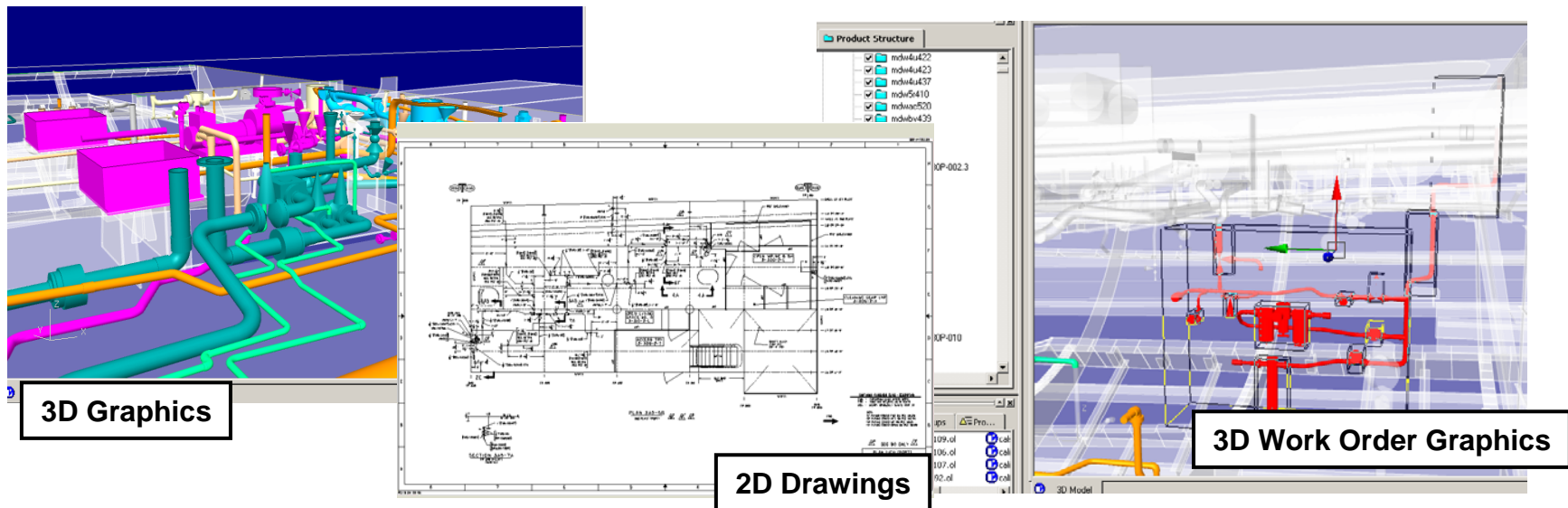
Production Design



- What is it?
 - 2D drawings, work orders and cut and bend data derived from 3D detailed design Models
- How is it used?
 - 2D drawings for ABS validation
 - Basis for production work paper
 - Test and Surveyor requirements
- How is it measured?
 - Foundation and assembly drawings to ABS
 - Drawing extraction starts and completes
 - Work order starts
- How is it validated by a third party?
 - Zone readiness reviews
 - ABS approvals

Production Design

- Single set of construction drawings in support of two shipbuilders based on MOA requirements
- Integrated tool suite allows model data to be introduced throughout the production process and facilities
- Replaces manual packaging of traditional 2D drawings



Multiple formats of production deliverables

Production Planning - Visual Simulations

Build Plan Validation

- Purpose is to validate job / work order content
- Multiple reviews performed with various stakeholders
- Process must complete prior to MacPac load / work order creation
- Participation:
 - Manufacturing Foreman
 - Design Build
 - Detail Scheduling

Build Plan Review

- Purpose is the detail scheduling of jobs
- Multiple reviews performed with key stakeholders
- Will occur 10 weeks prior to product start
- Participation:
 - Manufacturing FLS
 - Detail Scheduling

Readiness Review

- Purpose is crew familiarization and site configuration
- Typically will occur 2-3 weeks prior to product start
- Site configuration includes:
 - Scaffold placement
 - Safety
 - Material staging, etc.
- Participation:
 - Manufacturing crew
 - Detail Scheduling

Preparing the Shipbuilder for start fabrication

Summary

- The primary objective of the Detail Design Process is to integrate contractual requirements, specifications, engineering inputs and design build requirements to produce an efficiently executed ship design.
- Functional Design must be baselined prior to Zone Design start
 - Diagrams, scantlings, purchase specs, initial calculations, system descriptions and analyses
 - Final analyses
 - Validated by NTA/ABS
- Detail Design and Production Design are matured in support of controlled ramp up to full production
 - Final Arrangements complete prior to start fabrication
 - Model release supports production design and fab start
 - Procurement and planning done from models not drawings
 - Production Design must support ship construction needs
 - Validated through build plan reviews, construction pilots